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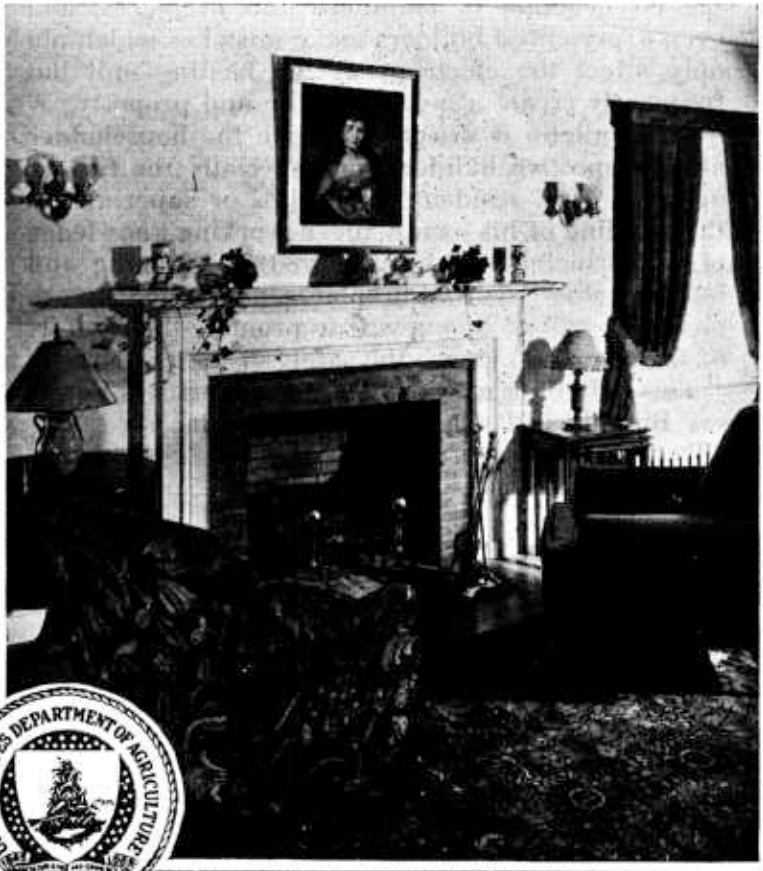
CONSTRUCTION OF CHIMNEYS AND FIREPLACES



THE OPEN FIRE has its place as a method of heating single rooms or small houses or as an adjunct of other heating systems. Even when not actually needed, it adds much to the enjoyment of home life, if the fireplace is properly built. Comparatively few understand the principles involved in the construction of chimneys and fireplaces, and even experienced builders make mistakes which not only affect the efficiency of the heating unit but frequently create a menace to life and property.

This bulletin is designed to give the householder and prospective builder, and especially the farmer or other rural resident who builds or superintends the building of his own home, a working knowledge of the principles to be observed in planning and building chimneys and fireplaces, which, if they are observed, will go a long way to promote the comfort of the home and insure the safety of the property.

This bulletin is a revision of and supersedes Farmers' Bulletin 1230, Chimneys and Fireplaces.

Washington, D. C. Issued November, 1930

CONSTRUCTION OF CHIMNEYS AND FIREPLACES

By the Division of Agricultural Engineering, Bureau of Public Roads

CONTENTS

INTRODUCTION [1]

FIREPLACES AND CHIMNEYS should provide a safe passage to the open air for unburned and partially burned products of combustion; that is, smoke and sparks. If they are of improper design or construction, the result is poor performance and frequently excessive fuel consumption. Defective chimneys and flues are responsible for much of the annual farm fire loss. According to the National Board of Fire Underwriters, overheated or defective chimneys, flues, cupolas, and stacks were responsible for the destruction of $26,343,759 worth of farm property during the five years 1924 to 1928, inclusive. The next greatest loss was that due to lightning and amounted to $17,727,780.

CHIMNEYS

COMMON FAULTS IN CHIMNEY CONSTRUCTION

The most common faults in chimney construction are:

The use of unsuitable or insufficient materials.

Improper laying of brick. Brick should not be laid on edge and should be properly bonded. Lack of mortar, especially in the perpendicular joints, ruins many an otherwise good chimney.

[1] Dwelling Houses, a publication issued by the National Board of Fire Underwriters in the interest of fire protection, has been used as a basis for the matter relating to the requirements and construction of chimneys and methods of fire protection.

Failure to support the chimney properly. It should never be carried on any timber construction of the building, and when it rests upon the ground sufficient masonry foundation should be provided to prevent settling.

Building inflammable material into the chimney or against it without proper insulation.

Failure to anchor the smoke pipe properly to the chimney.

Neglect of the connection between smoke pipe and flue or of the flue itself. The connection should be tight; rusted pipe should be replaced; the chimney should be kept clean and the joints in the brickwork properly pointed.

Lack of a tight flue. A flue free from leakage is unusual. Every flue should be tight enough to prevent escape of smoke when tested as described on page 11. A leaky flue is the most frequent cause of heating troubles, high fuel bills, and destructive fires.

Failure to maintain the full sectional area at the bend when a flue is offset.

Use of the main heating-apparatus flue for water-heater or other auxiliary equipment. Each heating unit should have a separate flue.

Improper installation of clean-out doors.

DRAFT

The draft depends entirely upon the chimney flue. The better the flue the more satisfactory and efficient will be the operation of the entire heating apparatus. The strength or intensity of the draft is dependent mainly upon the tightness, size, and height of the chimney. The most common error in chimney construction is failure to distinguish between the size of flue necessary for free passage of the volume of smoke from a given amount of fuel and that which with proper height will produce the required draft. A chimney may be high enough, yet have an area too small to carry properly the volume of smoke. On the other hand, the size may be sufficient but the chimney too low to produce a strong draft. Either fault or a combination of the two will result in unsatisfactory service.

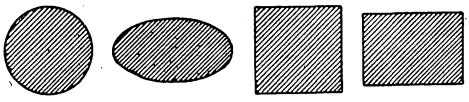
Draft in a chimney flue is caused by the difference in weight between a volume of air on the outside and an equal volume of products of combustion from the fire on the inside. The higher the temperature of a given weight of air, the greater is its total volume and the lighter the weight of its unit volume. This produces a condition of unbalanced pressure at the base of the flue. The rising of the lighter gases within the chimney tends to equalize the pressure. So long as the fire burns this condition of unbalanced pressure persists, the result being draft.

This is the basic principle which governs chimney action and upon which the draft depends. The greater the difference between the temperature in the flue and that outside the greater the tendency toward equalization of pressure and hence the better the draft. In summer the draft of a chimney is not as good as in winter because the difference in temperature between the outside air and that of the gases in the flue is less.

SHAPES AND SIZES OF FLUES

The most efficient chimney is one built perfectly straight with a round or nearly round flue and a smooth interior surface. There is no advantage in reducing the sectional area toward the top. The cross section and height are determining factors. The transverse area must be sufficient to pass the volume of air required to burn the fuel properly, and the height must be great enough to insure against interference with the draft by adjoining buildings or projections of the same building and to produce a sufficiently strong draft.

Loss in draft strength is due to air leakage and friction of the gases against the sides of the chimney. A round flue (fig. 1) is the most desirable because it offers less resistance to the spirally ascending column of smoke and gases. The elliptical is second choice so far as the movement of the gases is concerned, but the difficulties that it presents in manufacture and construction eliminate this shape. A rectangular chimney either square or oblong is not effective over its full transverse area; for the rising column being approximately circular in section, does not fill the corners. However, square or oblong forms are far more common than the round, owing to the greater cost of round-flue construction. Square flues are preferable to oblong so far as efficiency is concerned, but in the larger sizes of house flues the oblong shape is more generally used because it fits to better advantage into the plan of the house. An oblong flue should never have the long side more than 4 inches greater than the short side. The sizes given in Table 1 are recommended by the National Warm Air Heating and Ventilating Association. Like all data for both high and low pressure flues, these sizes are based on experience, not on scientific data, and are subject to modification by further research. The dimensions given are for unlined flues. The actual inside dimensions of fire-clay flue linings are slightly different because of the lack of standardization.



ROUND. ELLIPTICAL. SQUARE. OBLONG.

FIGURE 1.—Round flues offer the least resistance to the passage of gases, but most residence flues are made either square or oblong for structural reasons

TABLE 1.—*Sizes of chimney flue and height of chimney recommended*

Diameter of smoke pipe or round chimney flue	Size of chimney flue	Height of chimney flue above grate	Diameter of smoke pipe or round chimney flue	Size of chimney flue	Height of chimney flue above grate
Inches	*Inches*	*Feet*	*Inches*	*Inches*	*Feet*
8	8 by 12	35	15	16 by 16	45
9	8 by 12	35	16	16 by 18	45
10	12 by 12	35	17	16 by 20	50
11	12 by 12	40	18	16 by 20	55
12	12 by 12	40	19	20 by 20	55
13	12 by 16	40	20	20 by 24	60
14	12 by 16	45			

The flue for a furnace or other large heating unit should be not less than 8 by 12 inches and not less than 12 by 12 inches if the height, above the grate level, is more than 35 feet. If the chimney is designed for a small unit, such as a laundry stove or kitchen range, an 8 by 8 inch flue may serve.

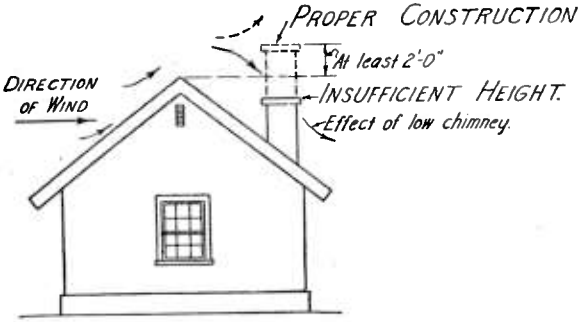


FIGURE 2.—Top of chimney should be at least 2 feet above the top of ridge in order that the wind currents may not be deflected down the chimney

The proper size of flue depends upon the size of the heater or furnace for which it is to be used. All manufacturers' catalogues contain the size of the smoke pipe for each particular heater, and from Table 1 minimum dimensions of corresponding round and rectangular flues may be obtained. If the catalogue gives stack dimensions the specified size should be used. Fire-clay flue linings should have a transverse net inside area approximately equal to that of the smoke pipe.

FIGURE 3.—Extensions to the chimney required in order that it might draw properly

HEIGHT OF CHIMNEY

In Table 1 the minimum height of the chimney above the grate is given as 35 feet. Higher chimneys are considered more satisfactory, and authorities claim that any flue under 40 feet in height will produce an erratic draft, good on some days but poor on others. The force or direction of the wind may be the cause, or the amount of moisture in the air, or the quality of the fuel may be responsible. The higher the chimney the less will be the possibility of counter air currents and the stronger and more constant the draft. Soft coal and the sizes of hard coal known as pea and buckwheat are apt to cake and fill up the air spaces through the bed of the fire, making an intense draft necessary to provide the fuel with sufficient air.

The top of the chimney should extend at least 3 feet above flat roofs and 2 feet above the ridge of peak roofs (figs. 2 and 3), and it should not be on the side of the house adjacent to a large tree or a

structure higher than itself (fig. 4), for these may cause eddies and force air down the chimney. A poor draft will most likely result when the wind is blowing in the direction indicated.

FLUE LININGS

Although chimneys are built without lining to save expense, those properly constructed with fire-clay flue linings are undoubtedly more efficient. Linings prevent disintegration of mortar and bricks through the action of flue gases. This disintegration and that occurring from changes in temperature result frequently in open cracks in the flue (fig. 5, B), which reduce or check the draft. If loose brick and mortar should fall within they may lodge so as to cause partial or almost complete stoppage. (Fig. 5, D.) The danger of this latter condition is greater if the flue be built with offsets or bends. Any change in direction should be made as gradual as possible and with an angle not greater than 30° with the perpendicular.

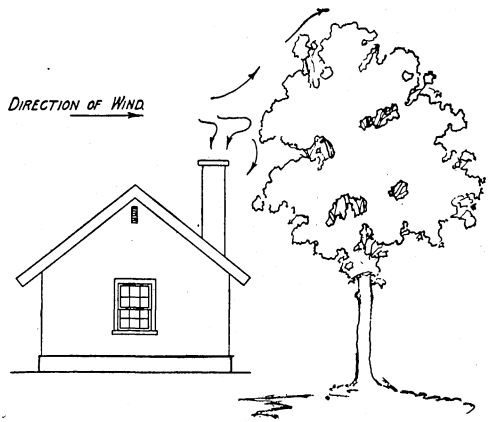


FIGURE 4.—Large trees located near chimney tops may deflect wind currents down the chimney. This may be avoided by placing the chimney on the opposite side of the building

The most important requirement for a flue lining is that it withstand high temperatures and not be subject to disintegration by ordinary flue gases. It should be made of fire clay not less than three-fourths of an inch thick. It should be set in cement mortar with the joints struck smooth on the inside. Each length of flue lining should be placed in position, and the brick should then be laid around it; if the lining is slipped down after several courses of brick have been laid, the joints can not properly be filled with mortar, and leakage is almost sure to result.

Well-burned clay flue linings are generally satisfactory for dwelling-house chimneys used for stoves, ranges, fireplaces, and furnaces. In regions where the fuel is natural gas, hot flue gases are said to have caused linings to disintegrate and crumble off. In such a case it may be necessary to use a fire clay that has stood the test or line the chimney with fire brick.

Linings are manufactured in round, square, and oblong shapes, but not in elliptical. The oblong and square shapes are better adapted to brick construction than the round. They permit of simpler and less expensive masonry work. On the other hand, the round shape produces better draft and is easier to clean.

LOCATION AND WALL THICKNESS

The best location for the chimney is near the center of the building, for when so located its four walls are kept warm; cold winds can not chill it and cause it to draw poorly. However, it is not always pos-

sible to plan the arrangement of rooms so that the chimney may be thus located. The outside wall of a chimney should be at least 8 inches thick in order to reduce heat loss and the chance of air leakage into the flue.

The walls of all chimneys should be built of brick, stone, reinforced concrete, or hollow units of clay or concrete. The minimum thickness of chimney walls not more than 30 feet high should be 4 inches for brick, 4 inches for reinforced concrete, 8 inches for hollow building units, and 12 inches for stone. All such chimneys should be lined. Linings may be omitted in chimneys having walls of reinforced concrete not less than 6 inches thick and unreinforced concrete or brick not less than 8 inches thick, although lining is desirable in the case of brick construction.

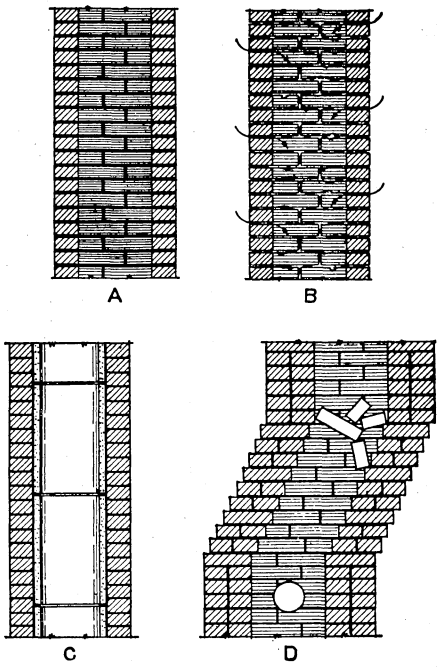


FIGURE 5.—A, an unlined chimney before use. B, same chimney, after being in service. Frequently the heat and weather cause the mortar to disintegrate so that air leaks in through the joints, causing a reduction in the draft. C, same chimney as A, showing fire-clay flue lining in place. D, an unlined chimney with offset. Loose brick and mortar may fall and become lodged at the offset during construction or loosening of the joints and disintegration may cause bricks from an uncapped chimney to check the draft completely

If there is more than one flue in a chimney, the flues should be separated from each other by a division wall of brick or concrete at least 4 inches thick (fig. 6), bonded into the side walls, and the joints of the flue linings should be staggered or offset at least 7 inches. This construction insures stability, reduces the chance for air leakage between flues, and prevents the possibility of a fire in one flue involving an adjacent flue.

Although not considered the best practice, it is sometimes necessary to place two linings in the same flue space, in which case the joints of such adjoining flue linings should be staggered at least 7 inches and particular care taken to see that all joints are well filled with mortar. Each flue intended for a heating furnace or boiler connection or for a fireplace should be separated from other flues.

OPENINGS INTO THE CHIMNEY

It is not unusual to find a second opening into a flue intended for the smoke pipe of the main heating apparatus. This is a frequent cause of unsatisfactory operation. No range, stove, fireplace, or ventilating register should be connected with the chimney flue built for the heating apparatus. If it is desired to use an abandoned fireplace chimney for a range or stove, the fireplace flue should be closed

tight about a foot below the place where the smoke pipe enters. There should be but one connection with a flue, if for no other reason than to decrease the fire hazard. Fires frequently occur from sparks that pass into the flue through one opening and out through another.

A soot pocket provided with a door for cleaning it out is sometimes very convenient. The door should be placed just below the smoke-pipe opening, and care must be taken to see that it fits snugly and is always closed so tight that no air can get in. If clean outs are used there should be one for each flue. If two or more flues are connected with a single clean out, air may be drawn from one to another, the draft in all of them being affected.

The value of the clean-out door is questionable since the metal smoke pipe connecting the heating unit and the chimney should be taken down each year for cleaning, at which time any accumulation of soot at the base of the chimney may be removed. Deep pockets permit accumulation of soot that may take fire. Linings of heater or stove flues should start from a point not less than 8 inches below the center line of the smoke-pipe intakes. Any hollow space below this point should be closed with solid masonry to prevent soot accumulation below.

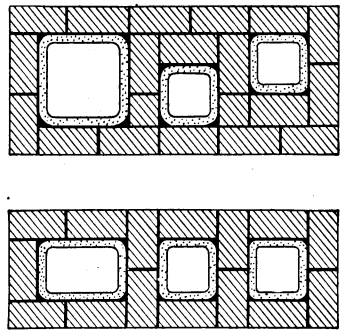


FIGURE 6.—A division wall of at least 4 inches of brick should separate each flue from any others in the same chimney. Either of the arrangements shown will produce a good bond

SUPPORTING THE CHIMNEY

All chimneys should be built from the ground up. None of the weight should be carried by any part of the building except the foundation. Proper foundations should be provided at least 12 inches wider all round than the chimney. If the chimney is an exterior one and there is no basement or cellar, its foundation should be started well below the frost line. Otherwise the base of the chimney should be at the same level as the bottom of the foundation of the building.

No chimney should rest upon or be carried by wooden floors, beams, or brackets, nor should it be hung from wooden rafters. Wood construction shrinks, and beams supporting heavy loads always deflect in time. Sagging of the beams injures the walls and ceilings of the house and is apt to crack the chimney and render it dangerous. Chimneys usually extend several feet above the roof, exposing considerable surface to the wind, and unless the support is stable they are likely to sway during a gale with the possibility of the joints at the roof line opening. Openings in a flue at this point are especially dangerous, for sparks from the flue may come into contact with the woodwork of the roof. This swaying may also cause leaks in the roof.

The brickwork around all fireplaces and flues should be laid with cement mortar, as it is more resistant than lime mortar to the action of heat and flue gases. It is well to use cement mortar for the entire chimney construction. All mortar used for chimney construc-

tion, except for laying fire brick, should be proportioned as follows: To one bag of Portland cement, not less than 94 pounds, add 9 pounds of dry hydrated lime, thoroughly mixing in dry form, and to the mixture add three times its volume of clean sand with sufficient water to produce proper consistency. When dry hydrated lime is not available, one-half cubic foot of completely slaked lime putty may be substituted for the dry hydrate.

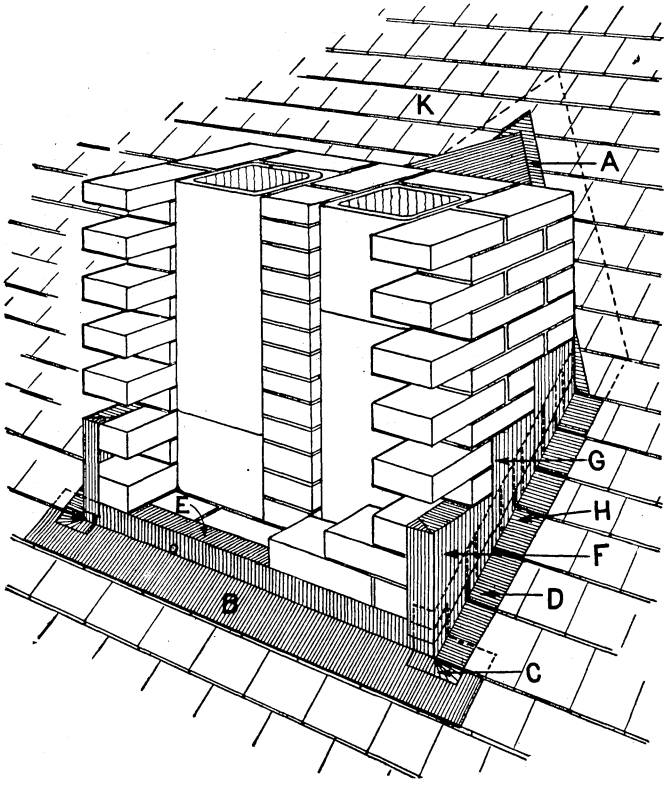


FIGURE 7.—Chimney and roof connection. Sheet metal A should extend under shingles K at least 4 inches. Apron B bent as at E with base flashings C, D, and H and cap flashings F and G, lapping over the base flashings provide watertight construction. When the chimney contains two flues the joints should be separated as shown

CAPPING THE CHIMNEY

Brick chimneys should be capped with stone, concrete, or cast iron. Unless a chimney is capped the top courses of brick may become loosened and therefore dangerous. Plain topped chimneys will last longer and are safer than those of an ornamental character. The opening in the cap piece should be the full size of the flue.

CHIMNEY AND ROOF CONNECTION

Where the chimney passes through the roof the construction should provide space for expansion due to temperature changes, settlement, or slight movement of the chimney during heavy winds. (Fig. 7.)

Copper is the best material for flashings. It is easier to handle than galvanized sheet metal, which is more often used because of its lower cost but which will corrode in time, both from inside and outside exposure. Tin or black iron are cheaper but will rust quickly unless frequently painted. Lead and zinc are expensive and should not be used for chimney flashings, for in case of fire under the roof they will melt and leave an opening to create a draft by which the intensity of the fire will be increased.

CHIMNEY CONNECTIONS

Proper care in setting and looking after smoke pipes connecting with chimneys would greatly lessen the number of fires chargeable to defective construction.

In fitting the smoke pipe no opening should be left around it, and the pipe should not project into the flue lining. (Fig. 8.) The joint should be made air-tight by a closely fitting collar and boiler putty or fireproof cement.

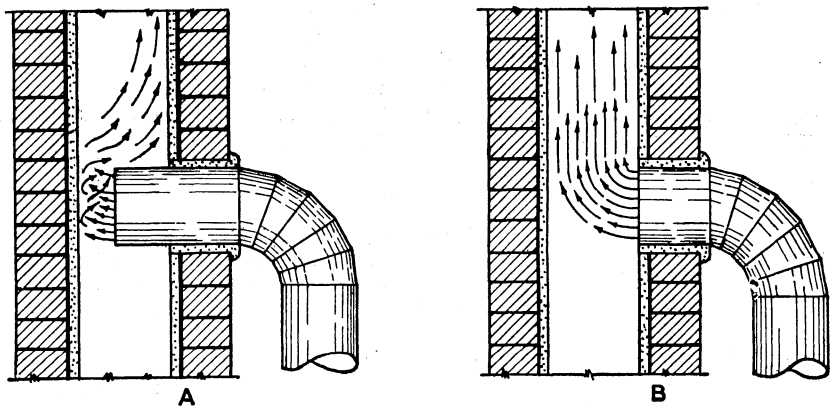


FIGURE 8.—A, wrong connection, producing interference and a poor draft; B, correct construction, producing a good draft by providing a free passage for the gases

Smoke pipes should enter the chimney horizontally, and the connection through the chimney wall to the flue should be made with fire clay or metal thimbles securely and tightly set in the masonry. If the walls are furred, no wood should be within 12 inches of thimbles or any part of the smoke pipe. The space between the thimble and wood furring should be covered with metal lath and plaster.

Flue holes when not in use should be closed with tight-fitting metal covers. If the room is papered, the metal covers may also be papered, provided there is no other smoke connection with the flue, or provided a protective coating of asbestos paper is first applied over the metal. If there is another connection, the metal may become hot enough to scorch the unprotected wall paper or set it afire. No smoke pipe should be permitted within 18 inches of any woodwork unless at least that half of the pipe nearest the woodwork is protected properly by 1 inch or more of fireproof covering. A metal casing 2 inches from the upper half of the pipe is sometimes

employed to protect woodwork directly above it. When a smoke pipe is so protected it should never be less than 9 inches from any woodwork or combustible material. The storage of wooden boxes, barrels, or any combustible material should not be permitted under or near a furnace smoke pipe.

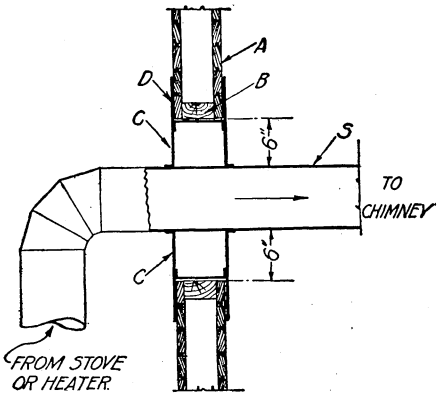


FIGURE 9.—Smoke pipe passing through a partition. A, 7/8-inch sides of partition; B, 2 by 4 studs in partition; C, ventilating holes in the double galvanized-iron ventilating thimble D. Thimble should be at least 12 inches larger than pipe S

If a smoke pipe must be carried through a wood partition, the woodwork should be properly protected. This can be done by cutting an opening in the partition and inserting a galvanized-iron double-wall ventilating thimble at least 12 inches larger than the smoke pipe (fig. 9), or protection may be afforded by at least 4 inches of brickwork or other incombustible material. Smoke pipes should not pass through floors, closets, or concealed spaces. They should not enter a chimney in a garret. They should be cleaned at least once a year.

CHIMNEY INSULATION

All wooden construction adjacent to chimneys should be insulated. A space of 2 inches should be left between the outside face of a chimney and all wooden beams or joists. This space should be filled with some porous, nonmetallic, incombustible material. Loose cinders serve well. Brickwork, mortar, or solid concrete should not be used. The filling should be done before the floor is laid, as it not only forms a fire stop but prevents accumulation of shavings or other combustible material. Baseboards fastened to plaster which is directly in contact with the outside wall of a chimney should be protected by placing a layer of fireproof material at least one-eighth inch thick between the woodwork and the plaster. (Fig. 10.)

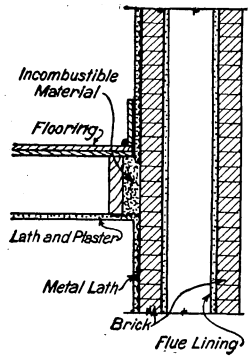


FIGURE 10.—No woodwork should be permitted closer than 2 inches to the outside face of a chimney. Baseboards in front of chimneys should be protected with asbestos board

Wooden studding, furring, or lathing should not under any circumstances be placed against a chimney. Wooden construction should be set back from the chimney as indicated in Figures 11 and 12; or the plaster may be applied directly to the masonry or to metal lathing laid over the masonry. The former is the better method, as settlement of the chimney will not then crack the plaster. It is recommended that a coat of cement plaster be applied directly upon the masonry of any parts of a chimney that are to be incased by a wooden partition or other combustible construction.

SMOKE TEST FOR LEAKAGE

Every flue should be subjected to a smoke test before the heater is connected with it. This may be done as follows: Build a paper, straw, wood, or tar-paper fire at the base of the flue, and when the smoke is passing in a dense column tightly block the outlet at the top by laying a wet blanket over it. If leakage exists at any point it will immediately become apparent by the appearance of smoke at the opening. Flues so tested frequently reveal very bad leaks into adjoining flues or directly through the walls or between the linings and the wall. When the smoke test indicates leakage the defect should be remedied before the chimney is accepted for use. Remedying such defects is usually difficult, hence it is wise to watch the construction closely as it progresses. Many brick masons say that all flues leak. This is not true; every flue should be tight.

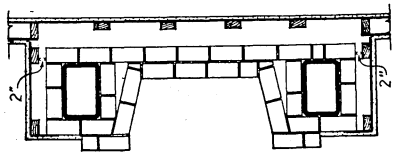


FIGURE 11.—No wooden studding, furring, or lathing should be placed against the chimney. It should be set back as indicated in this figure and in Figure 12

CLEANING AND REPAIRING THE FLUE

If a smoke test shows no leakage and the flue is straight, a hand mirror held at the proper angle at the base affords a means of examination for obstructions. Usual causes of stoppage are broken tile leaning inward, mortar accumulations, loose bricks, birds' nests, partly burned paper, soot from soft coal, tarry deposits from burning wood, etc. A weighted bag of hay or straw attached to the end of a rope may be passed up and down the flue to clean it if there is not too great an offset in it.

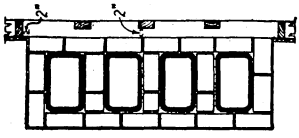


FIGURE 12.—In this construction the chimney masonry is entirely free of all woodwork. Expansion and contraction of the chimney will not crack the plaster if a slip joint is made in the plaster at the intersection of chimney and wall surfaces

FIREPLACES

The use of the fireplace is a very old method of house heating. As ordinarily constructed fireplaces are not efficient and economical. The only warming effect is produced by the heat given off by radiation from the fire and from the back, sides, and hearth of the fireplace. Practically no heating effect is produced by convection; that is, by air currents. The air passes through the fire and up the chimney, carrying with it the heat absorbed from the fire. At the same time outside air of a lower temperature is drawn into the room. The effect of the cold air thus brought into the room is particularly noticeable in parts of a room farthest from the fire.

The open fireplace, however, has its place as an auxiliary to the heating plant and for the hominess that a burning fire imparts to the room. If one is to be provided, the essentials of construction should be understood and followed so that it will not smoke.

ESSENTIALS OF FIREPLACE CONSTRUCTION

In order that satisfactory results may be obtained from an open fireplace, it is essential (1) that the flue have the proper area, (2) that the throat be correctly proportioned and located, (3) that a properly constructed smoke shelf and chamber be provided, (4) that the chimney be carried high enough to avoid interference with the draft, and (5) that the shape of the fireplace be such as to direct a maximum amount of radiated heat into the room.

AREA OF THE FLUE

The sectional area of the flue bears a direct relation to the area of the fireplace opening. The area of lined flues should be a tenth or

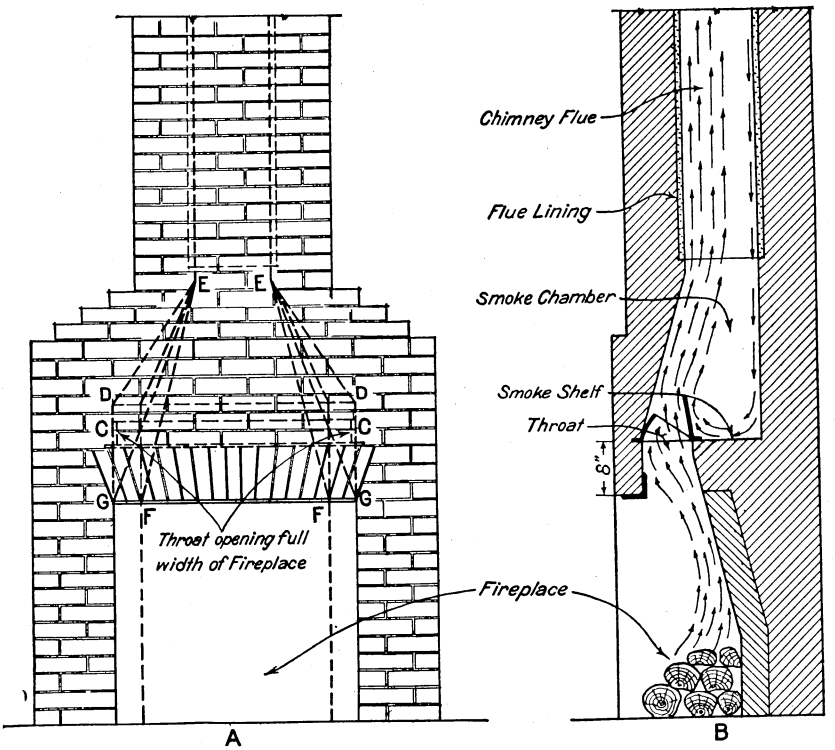


FIGURE 13.—A, top of throat damper is at DD, smoke shelf at CC. Side wall should not be drawn in until the height DD is passed. This assures full area. If the drawing in is done as indicated by lines EF and EG, the width of the throat becomes less than the width of the opening and causes the air currents to pile up in the corners of the throat, resulting frequently in a smoky fireplace. B, correct fireplace construction

more of that of the fireplace opening. If the flues are unlined, the proportion should be increased slightly because of greater friction. Thirteen square inches of area for the chimney flue to every square foot of fireplace opening is a good rule to follow. For the fireplace shown in Figure 13, A, the opening of which has an area of 8.25 square feet, there is required a flue having an area of 107 square inches. If this flue were built of brick and unlined, it would prob-

ably be made 8 inches by 16 inches, or 128 square inches, because brickwork can be laid to better advantage when the dimensions of the flue are multiples of 4 inches. If the flue is lined, the lining should have an inside area approximating 107 square inches. It is seldom possible to obtain lining having the exact required area, but the clear area should never be less than that prescribed above.

Failure to provide a chimney flue of sufficient sectional area is in many instances the cause of an unsatisfactory fireplace. The cross section should be the same throughout the entire length of the chimney. The flue should not be contracted at the chimney top, for that would nullify the larger opening below; if it is necessary to change the direction of a flue the full area should be preserved through all turns and bends, and the change should be made as gradual as possible.

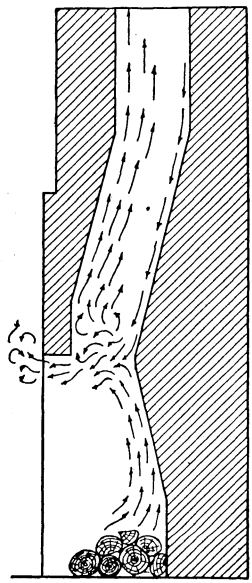


FIGURE 14. — Fireplaces constructed like this without throat will very likely smoke

THE THROAT

In Figure 13, B, is shown the throat, the narrow opening between the fireplace and the smoke chamber. Correct throat construction contributes more to efficiency than any other feature except proper flue design. A flue twice as large as is necessary brought straight down to the fireplace without constriction at the throat would result in a poor draft, for the draft does not depend upon the largeness of the flue but upon its proper proportioning to the fireplace and throat. The arrows indicate the upward flowing currents of warm air which are thrown forward at the throat and pass through the smoke chamber into the flue on the inner side. This rapid upward passage of air causes a down current on the opposite side, as indicated by the descending arrows. The down current is not nearly as strong as the up current, but it may be of such force that if there is no throat in the fireplace (fig. 14) to increase the velocity of the upward current by constricting it, the meeting of the two currents will result in smoke being forced out into the room. Thus it frequently happens that a fireplace has an ample flue area and yet smokes badly. The influence of the throat upon the upward and downward air currents is shown in Figure 13, B.

The area of the throat should not be less than that of the flue. Its length should always be equal to the width of the fireplace opening. (Fig. 13, A.) The sides of the fireplace should be vertical until the throat is passed. (DD in fig. 13, A.) Above the throat the sides should be drawn in until the desired flue area is attained. The throat should be set 8 inches above the location of the lintel, as shown in Figure 13, A and B. The wrong way to place the throat damper is shown in Figure 15. The throat should not be more than 4 or 5 inches wide. The lesser width is a safe standard. If a damper is

installed, the width of the brick opening at the throat will depend upon the width of the frame of the damper, the width of the throat proper being regulated by the hinged cover of the damper. If the throat damper is omitted, the opening should be 4 inches, as shown in Figure 16. The smoke shelf should not be bricked up, but should conform to the dotted lines. The depth of the smoke shelf should be the same for a 2-foot as for a 10-foot fireplace opening.

Proper throat construction is so necessary to a successful fireplace that the work should be carefully watched to see that the width is not made more than 4 inches and that the side walls are carried up perpendicularly until the throat is passed, so that the full length of opening is provided. All masons do not appreciate these fine but necessary points. Many prefer their own methods and sometimes will ignore the proper methods. It is therefore advisable to inspect the work several times a day as it progresses and thus avoid poor results. When trouble is experienced in an existing fireplace that has ample flue area, it is usually found that the formation of the throat is the cause.

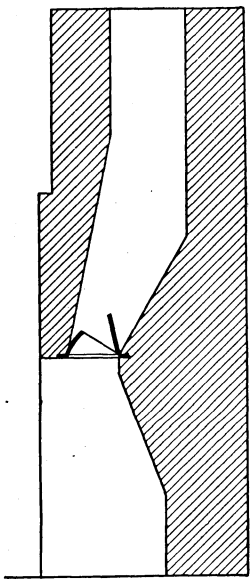


FIGURE 15.—Wrong location for throat damper. The throat is so low that the accumulation of gases at the point constricted weakens rather than improves the draft with greater likelihood of a smoky fireplace. Note that the smoke shelf is bricked up. This is wrong

SMOKE SHELF AND CHAMBER

A smoke shelf and chamber are absolutely essential. The shelf is formed by setting the brickwork back at the top of the throat to the line of the flue wall. The shelf should be the full length of the throat. The depth of the shelf should be not less than 4 inches. It may vary from this to 12 inches or more, depending upon the depth of the fireplace.

The purpose of the smoke shelf is to change the direction of the down draft so that the hot gases at the throat will strike it approximately at a right angle instead of head on. Therefore the shelf should not be bricked up as in Figures 15 and 16, but should be made as wide as the construction will permit at a height of 8 inches above the top of the fireplace opening.

The smoke chamber is the space extending from the top of the throat up to the bottom of the flue proper and between the side walls, which may be drawn in after the top of the throat is passed. The area at the bottom of the chamber is quite large, since its width includes that of the throat added to the depth of the smoke shelf. This space is capable of holding accumulated smoke temporarily in case a gust of wind across the top of the chimney momentarily cuts off the draft. Smoke might be forced into the room if there were no reservoir to hold it. The smoke chamber also lessens the force of the down draft by increasing the area through which it passes. If the walls are drawn inward 1 foot for each 18 inches of rise, friction is reduced and interference with the draft lessened.

The walls of the smoke chamber should be smoothly plastered with cement mortar not less than one-half inch thick, for roughness seriously impedes the upward movement of the air currents.

SHAPE OF THE FIREPLACE

The shape of the fireplace proper should be as indicated in Figure 13, A. The back should pitch forward from a point a little less than half way from the hearth to the top of the opening, and the sides should be beveled as indicated. Straight back and sides do not radiate as much heat into the room.

THE THROAT DAMPER

A properly designed throat damper affords a means of regulating the fire. The damper consists of a cast-iron frame with a lid hinged so that the width of the throat opening may be varied from nothing to 6 inches. There are a number of patterns on the market, some of which are designed to support the masonry over the fireplace opening.

A roaring pine fire requires a full throat opening, but slow-burning hardwood logs require but 1 or 2 inches of opening. Regulating the opening according to the kind of fire prevents waste of heat up the chimney. Closing the opening completely in summer keeps flies, mosquitoes, and other insects from entering the house by way of the chimney.

In houses heated by furnaces or other modern systems fireplaces without throat dampers interfere with even heating, particularly in very cold weather. An open fire must be supplied with air, and the larger the fire the greater the quantity required; a fireplace with a width of 5 feet or more may pull air from distant parts of the house. This air that is heated at the expenditure of fuel in the furnace is carried up the chimney and wasted, but with a throat damper open only 1 or 2 inches a slow fire of hardwood can be kept going without smoking the room, thus reducing materially the waste of hot air.

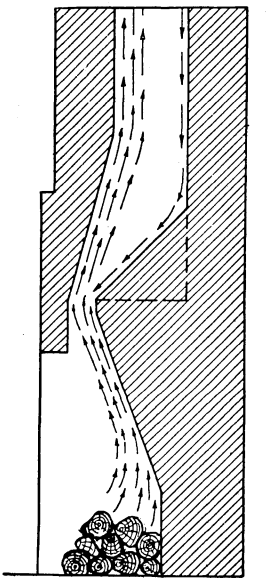


FIGURE 16.—This construction without a throat damper directs the down draft so that it meets the up draft almost at the throat. This is a more serious fault than the construction shown in Figure 15, in which the lid of the damper deflects the down current

The throat damper should be as wide as the fireplace, so the side walls should not be drawn in until after the throat is passed. Smoke dampers with lid hinged at the back will help the smoke shelf to turn the down draft; if the lid is hinged in the center the downward and upward currents are apt to conflict. The placing of the damper varies with the type, but generally the bottom of the frame is built into the brickwork at the level of the top of the fireplace opening, forming the throat and supporting the masonry above it.

SIZE OF FIREPLACE

Pleasing proportions in the fireplace opening are desirable. The width should generally be greater than the height, but as 30 inches is about the minimum height consistent with convenience in tending the fire, a narrow opening may be made square. Three feet and a half is a good maximum for height of opening unless the fireplace is over 6 feet wide. The higher the opening the greater the chance of a smoky fireplace.

A fireplace should be in harmony with the rest of the room in proportions and details. This consideration and the kind of fuel to be used largely determine the size of opening.

Generally speaking the day of large farmhouse fireplaces capable of receiving cordwood is past. The tending of fires usually falls to the housewife, and cordwood is a heavier weight than she should handle, and it can not be stored near at hand. Cordwood cut in two is easily handled; so that a 30-inch width is about the minimum for farmhouses where wood is used for fuel. If coal is burned the opening may be made narrower.

Unless a fireplace with a 6-foot opening is made fully 28 inches deep, in order that large logs may lie well inside, the advantage of the wide opening is lost, for the logs will have to be split. A shallow opening throws out more heat than a deep one of the same width, but can take only sticks of smaller diameter; thus it becomes a question of preference between the greater depth which permits of large logs that burn longer and require less frequent replenishing and the shallower which takes lighter sticks and throws more heat.

In small fireplaces a depth of 12 inches will permit good draft, if the throat is constructed as explained above, but a minimum depth of 18 inches is advised to lessen the danger of brands falling out on the floor. Wire guards should be placed in front of all fireplaces. In general, the wider the opening the greater should be the depth.

THE HEARTH

The hearth should be flush with the floor, for sweepings may then be brushed into the fireplace. An ash dump located in the hearth near the back of the fireplace is convenient for clearing ashes and other refuse from the hearth provided there is space below for an ash pit. The dump consists of a cast-iron metal frame, with pivoted cover, through which the refuse can be brushed into the ash pit below. The ash pit should be of perfectly tight masonry and provided with a tightly fitting clean-out door.

THE JAMB

The jambs of the fireplace should be of sufficient width to give stability to the structure both actually and in appearance. For a fireplace opening 3 feet wide or less, 16 inches is generally sufficient; for wider openings similar proportions should be kept. Greater widths may be required to harmonize with the proportions of the rooms, and the above should be taken as a minimum.

FIREPLACE BACK AND SIDES

The back and sides of the fireplace should be constructed of fire brick only. The bricks should be laid flat with the long sides exposed, for if placed on edge there is danger of their falling out.

SUPPORTING IRONS

In small fireplaces sagging of the arch over the opening seldom occurs, but in fireplaces over 4 feet wide it is not uncommon. It is due to insufficient support of the masonry. Except in massive construction there generally is not sufficient masonry at the sides of the opening to resist the thrust of arch construction; hence it is usual to support the masonry with iron, which, if too light, will sag. Too small an iron will become so hot that its tensile strength is lowered until it bends. A heavy flat bar at least one-half inch thick is sometimes used or a T bar which has greater strength, but less metal; the wider the opening the heavier the bar required.

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